

WHAT IS CLAIMED IS:

1           1.       A system for preventing acoustic shock comprising:  
2                   a variable attenuator attenuating an input signal by a variable  
3                   attenuation amount to produce an output signal;  
4                   a frequency analyzer operative to convert a time-windowed portion  
5                   of the input signal into a plurality of frequency bins, each frequency bin expressing  
6                   the energy of the time-windowed portion of the input signal over a particular  
7                   frequency range;  
8                   an energy calculator which determines a relative energy signal having  
9                   an element corresponding to each frequency bin, each element of the relative energy  
10                  signal based on energy magnitude in the corresponding frequency bin relative to a  
11                  total energy of the time-windowed portion of the input signal;  
12                  a plurality of signal detectors, each detector in communication with  
13                  the energy calculator, each signal detector generating a detection signal for  
14                  modifying the variable attenuation amount based on the relative energy signal, at  
15                  least one of the detection signals comprising a vector of attenuation elements, each  
16                  attenuation element in the vector of attenuation elements corresponding to one of the  
17                  frequency bins; and  
18                  attenuation logic in communication with the variable attenuator and  
19                  the plurality of signal detectors, the attenuation logic determining an attenuation  
20                  value signal controlling the variable attenuation amount based on the plurality of  
21                  detection signals.

1           2.       The system of claim 1 wherein at least one of the signal  
2           detection signals, when asserted, inhibits attenuation by the variable attenuator.

1           3.       The system of claim 1 further comprising:  
2                   a difference calculator which calculates a difference signal based on  
3                   a difference in energy between each pair of adjacent frequency bins;  
4                   a general tone detector as one of the plurality of signal detectors, the tone  
5                   general tone detector in communication with the difference calculator, the tone

6      detector generating a general tone detection signal based on the relative energy  
7      signal and on the difference signal.

1                  4.      The system of claim 3 wherein the general tone detection  
2      signal is one of the at least one detection signal comprising a vector of attenuation  
3      elements, the general tone detector generating an assertion for each of the general  
4      tone detection signal elements if that particular element has a corresponding  
5      difference signal element exceeding a difference threshold and a corresponding  
6      relative energy signal element less than a relative energy threshold.

1                  5.      The system of claim 3 further comprising a time averaging  
2      filter averaging the difference in energy between at least one of pair of adjacent  
3      frequency bins.

1                  6.      The system of claim 1 wherein the plurality of signal detectors  
2      comprises a fax/modem detector generating a fax/modem detection signal based on  
3      any element in a subset of the relative energy signal exceeding a preset threshold.

1                  7.      The system of claim 1 wherein the plurality of signal detectors  
2      comprises a select tone detector generating a select tone detection signal based on  
3      at least one element of the relative energy signal exceeding a preset threshold, each  
4      of the at least one relative energy signal element corresponding to a known select  
5      tone frequency.

1                  8.      The system of claim 7 wherein the select tone detector selects  
2      at least one from a set including at least one dial tone and at least one ring tone.

1                  9.      The system of claim 1 wherein the attenuation logic scales  
2      each attenuation element of at least one of the detection signals comprising a vector  
3      of attenuation elements.

1                   10. The system of claim 1 wherein the attenuation logic  
2 implements a spreading filter across the attenuation elements of at least one of the  
3 detection signals comprising a vector of attenuation elements.

1                   11. The system of claim 1 further comprising a noise canceller for  
2 cancelling noise in the output signal.

1                   12. The system of claim 1 further comprising a compressor for  
2 amplitude compression of the output signal.

1                   13. The system of claim 1 wherein the attenuation value signal  
2 comprises a vector of attenuation elements, each attenuation element corresponding  
3 with one of the frequency bins.

1                   14. A method of reducing acoustic shock comprising:  
2                   obtaining the spectrum of an input signal, the spectrum including a  
3 plurality of frequency bins, each bin representing the magnitude of the spectrum  
4 over a particular frequency range;

5                   determining a relative energy signal as a plurality of relative energy  
6 elements, each relative energy element representing the relative energy in a  
7 corresponding frequency bin;

8                   determining a difference signal as a plurality of difference elements,  
9 each difference element representing a difference between a corresponding  
10 frequency bin value and an adjacent frequency bin value;

11                  determining a plurality of detection signals, each detection signal  
12 detecting the presence of a sound element in the input signal based on at least one  
13 of the relative energy signal and the difference signal;

14                  combining the plurality of detection signals to produce an attenuation  
15 signal, the attenuation signal comprising an attenuation element corresponding to  
16 each frequency bin; and

17                  attenuating the input signal using the attenuation signal.

1               15.     The method of claim 14 wherein determining a plurality of  
2 detection signals comprises determining a general tone detection signal based on the  
3 relative energy signal and the difference signal, the tone detection signal comprising  
4 a plurality of general tone detection elements, each general tone detection element  
5 corresponding to one of the frequency bins.

1               16.     The method of claim 14 wherein the value of each general  
2 tone detection element is a logical one if the corresponding difference element has  
3 a value greater than a difference threshold and if the corresponding relative energy  
4 element has a value less than a relative energy threshold.

1               17.     The method of claim 14 wherein determining a plurality of  
2 detection signals comprises determining a fax/modem detection signal based on a  
3 subset of the relative energy signal, the subset based on frequencies known to  
4 exhibit fax/modem tones.

1               18.     The method of claim 13 wherein determining a plurality of  
2 detection signals comprises determining a select tone detection signal based on a  
3 subset of the relative energy signal, the subset based on frequencies known to  
4 exhibit at least one select tone.

1               19.     The method of claim 18 wherein the at least one select tone  
2 comprises a ring tone.

1               20.     The method of claim 18 wherein the at least one select tone  
2 comprises a dial tone.

1               21.     The method of claim 18 wherein combining the plurality of  
2 detection signals comprises decreasing attenuation if a select tone is detected.

1               22.     The method of claim 14 further comprising spread filtering  
2 at least one of the plurality of detection signals having a plurality of detection  
3 elements.

1                   23. The method of claim 14 further comprising cancelling noise  
2 in the attenuated input signal.

1                   24. The method of claim 14 further comprising amplitude  
2 compressing the attenuated input signal.

1                   25. A method of reducing acoustic shock comprising:  
2                   obtaining the spectrum of an input signal;  
3                   determining a relative energy signal as a function of frequency based  
4 on the spectrum;  
5                   determining a difference signal based on a change in magnitude in the  
6 spectrum as a function of frequency;  
7                   determining a general tone signal as a function of the relative energy  
8 signal and the difference signal;  
9                   determining a fax/modem signal as a function of the relative energy  
10 signal;  
11                  determining a select tone signal as a function of the relative energy  
12 signal;  
13                  determining an attenuation signal as a function of frequency based on  
14 the general tone signal, the fax/modem signal and the select tone signal; and  
15                  attenuating a sound signal based on the attenuation signal.

1                   26. The method of claim 25 wherein the select tone signal is used  
2 to block attenuation otherwise caused by at least one of the general tone signal and  
3 the fax/modem signal.

1                   27. The method of claim 25 wherein the general tone signal  
2 increases attenuation if, for a given frequency, the difference signal is above a  
3 difference threshold.

1                   28. The method of claim 25 wherein the general tone signal  
2 increases attenuation if, for a given frequency, the relative energy signal is below  
3 a difference threshold.

1                   29. A method of preventing acoustic shock comprising:  
2                   detecting for the presence of at least one general tone;  
3                   detecting for the presence of at least one fax/modem tone;  
4                   detecting for the presence of a select tone, the select tone being at  
5 least one signal from a set including at least one dial tone and at least one ring tone;  
6 and  
7                   attenuating a sound signal if at least one of the at least one general  
8 tone is detected and the at least one fax/modem tone is detected but only if the at  
9 least one select tone is not detected.